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Amphibia, Anura, Leiuperidae, *Pleurodema thaul* (Lesson, 1827): Altitudinal distribution extension and new records from its northern range

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ABSTRACT: The current study reports five new localities of the four-eyed frog *Pleurodema thaul* (Lesson, 1827) in the extreme north of its distribution (27° to 30° S) in the desertic and semidesertic ravines of Chile, including an increase in its altitudinal range up to 3125 m.

The four-eyed frog *Pleurodema thaul* (Lesson, 1827) is one of the most abundant and widely distributed amphibians of Chile (Cei 1962), extending from Carrera Pinto (27°06' S) to the Aysén region (about 46°S; Veloso and Navarro 1988; Correa *et al.* 2007; Figure 1). In Argentina it is only found on the eastern border of the Andes between about 37° and 46° S (Cei 1980). The upper limit of its altitudinal range was recently extended to 2727 m (Correa *et al.* 2007). However, this information has not been incorporated in some sources that indicate its limit as 2000 or 2100 m (Díaz-Páez *et al.* 2008; IUCN 2009).

The Chilean area in which *P. thaul* is found presents a gradual transition from north to south, from a hyperdesertic Mediterranean bioclimate to a hyperoceanic temperate one (Luebert and Pliscoff 2006). Consequently, the species inhabits both isolated oasis in the northern desert (e.g. Carrera Pinto; Correa *et al.* 2007) and in temperate rainforests of southern Chile and Argentina, embracing an altitudinal range between 0 and 2727 m, which reflects its ecological plasticity (Cei 1962). The species has also invaded almost all of Robinson Crusoe Island (archipelago Juan Fernández, South Pacific, Chile) after being introduced in the 1970's (Correa *et al.* 2008a), which ratifies its adaptive capacity.

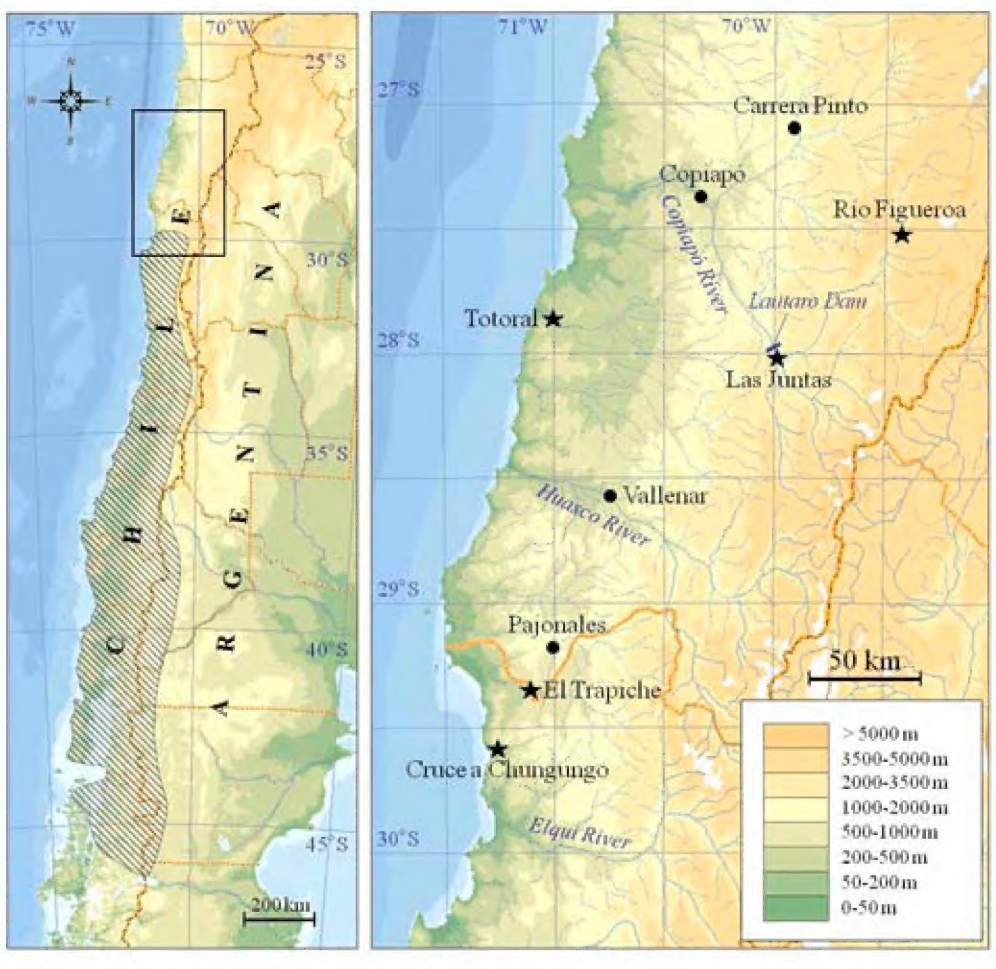

FIGURE 1. Distribution map of *Pleurodema thaul* showing the known localities north of 30° S (map on the right, also see Table 1). New localities are indicated by a star. The hatched area in the map on the left represents the continuous distribution south of 30º S, according to Duellman and Veloso (1977).

According to Duellman and Veloso (1977), the distribution of *P. thaul* in Chile is discontinuous north of La Serena (30° S), due to the aridity of this region. In fact, up to now only four localities north of this latitude had been described for the species, in an area covering approximately 320 km. Two of these localities are in the only rivers of the zone that flow all year long (Huasco river and Copiapó river; Figure 1; Correa *et al.* 2007); the other two are found in small isolated streams in ravines of the desert (Carrera Pinto) and semi-desert (Pajonales) area. The scarcity of natural aquatic habits due the reduction of precipitation towards the north can explain why only two species of amphibians, *P. thaul* and *Rhinella atacamensis*, have colonized Chile north of 30° S; the latter is the only species found between 25° and 27° S (Correa *et al.* 2008b).

The small number of amphibian populations described in this zone is not only due to the arid conditions, but also to a lack of exploration, as may be deduced from the recent description of new localities of *R. atacamensis* in the same area (Correa *et al.* 2008b). Here we report five new localities of *P. thaul* in the extreme north of its distribution (27° to 30° S), including one which increases its altitudinal range to 3125 m (Río Figueroa; Table 1; Figure 2), which are a result of recent explorations in the zone (2006-2009). Two of these localities are in the drainage system of the Copiapó river (Las Juntas and Río Figueroa), while the other three

Table 1. Coordinates and elevations of the localities of *Pleurodema thaul* mentioned in the literature north of the Elqui river basin (30° S) and of the new localities described in this report. See the map of Figure 1.

Locality	Latitude (S)	Longitude (W)	Altitude (m)	Reference
Carrera Pinto	27°06'40.2"	69°53'44.3"	1565	Correa *et al.* (2007)
Copiapó (city)	27°21'55.7"	70°20'32.7"	381	Cei (1962)
Río Figueroa	27°31'43.2"	69°26'27.9"	3125	This report
Totoral	27°54'04.1"	70°57'10.1"	163	This report
Las Juntas	28°00'16.0"	69°58'37.0"	1161	This report
Vallenar	28°35'07.7"	70°44'38.9"	403	Cei (1962)
Pajonales	29°08'42.9"	70°59'45.2"	1010	Duellman and Veloso (1977)
El Trapiche	29°20'34.1"	71°09'14.3"	242	This report
Cruce a Chungungo	29°35'12.5"	71°15'10.4"	161	This report

Figure 2. Adult of *Pleurodema thaul* from Río Figueroa, Atacama region, Chile.

are coastal ravines with little water. Frogs were collected from each of these localities for genetic and neuroethological studies and were deposited in the Herpetological Collection of the Departamento de Biología Celular y Genética of the Universidad de Chile (DBGUCH).

Río Figueroa is a mountain stream fed by underground springs, which in some places forms small ponds and swamps (Figure 3A). The area appears little disturbed by human activities and harbors an abundant population of the species. Las Juntas is a small town located close to the junction of the Manflas and Copiapó rivers, mostly dedicated to agriculture. The Copiapó river is channeled in this area, but there are a few places beside the canal where there is a slow flow of water where individuals of *P. thaul* and *R. atacamensis* may be found. Totoral is a very small town whose inhabitants are mainly farmers and artisans. Frogs can be found in a nearby ravine (Figure 3B), which only has an abundant flow of water from June to September. Totoral has the population of *P. thaul* with the smallest body size found so far (mean SVL = 29 mm, SVL range 25.3-31.3 mm) (N. Velásquez and M. Penna, unpublished data). El Trapiche is a small creek where mainly farming activities are developed (Figure 3C). Finally, Cruce a Chungungo is a superficial runoff which forms small ponds in which both *P. thaul* and *R. atacamensis* live (Figure 3D).

The distributional limits of *P. thaul* appear to be determined by the same factors that determine the species richness of amphibians in Chile. The majority of the species are concentrated between 38° and 48° S; their richness and abundance diminishes both north and south of this area due to more extreme climatic conditions (Veloso and Navarro 1988; Vidal 2008). In the extreme south, temperate forests give way to Patagonian steppes and Magallenic tundra, where only two species can be found south of 50° S. One of these species, *P. bufonina*, is widely distributed in the Patagonia of Argentina and Chile and replaces *P. thaul* in Chile from approximately 46° S to the south (Cei 1962). By contrast, the Atacama Desert, whose southern limit is about 28° S, limits the presence of amphibians to the coast and interior of the country.

Human pressure increases as water resources decrease towards the north of Chile, which is exacerbated by the intense mining and agricultural activities in this zone of the country. This has affected the integrity of the water drainage systems, affecting the habitat of amphibians directly or indirectly, as was recently shown for some *R. atacamensis* localities (Correa *et al.* 2008b). The current state of the Copiapó river exemplifies the negative effects of human activities. This river is channeled from Lautaro dam downriver (Figure 1), where its natural course is completely dry. Recent exploration around the city of Copiapó and towards the outlet of the river, where *P. thaul* used to be common, has not detected individuals of this species or of *R. atacamensis* (C. Correa, G. Lobos, personal observations). The situation upriver from the Lautaro dam is different; here the Copiapó river and its affluents still have significant water flow, albeit intermittent. However, there are currently intensive agricultural and mining activities which could affect the persistence of the recently discovered populations of *P. thaul* in Las Juntas and Río Figueroa. This last locality is of particular importance, not only because it increases the known altitude limit of *P. thaul*, but also because it shows that this species is capable of resisting the extreme climatic conditions of the high-altitude desert (Figure 3A).

In summary, *P. thaul* has been capable of persisting in the isolated and reduced water courses of water in the Chilean desert and semi-desert zone, in areas which are currently threatened by the growing human pressure on the water resources (*e.g.* Correa *et al.* 2008b). It is not currently known if these populations have genetic or ecological differences with respect to their more southern counterparts. We also know nothing about the population dynamics in these environments, whose

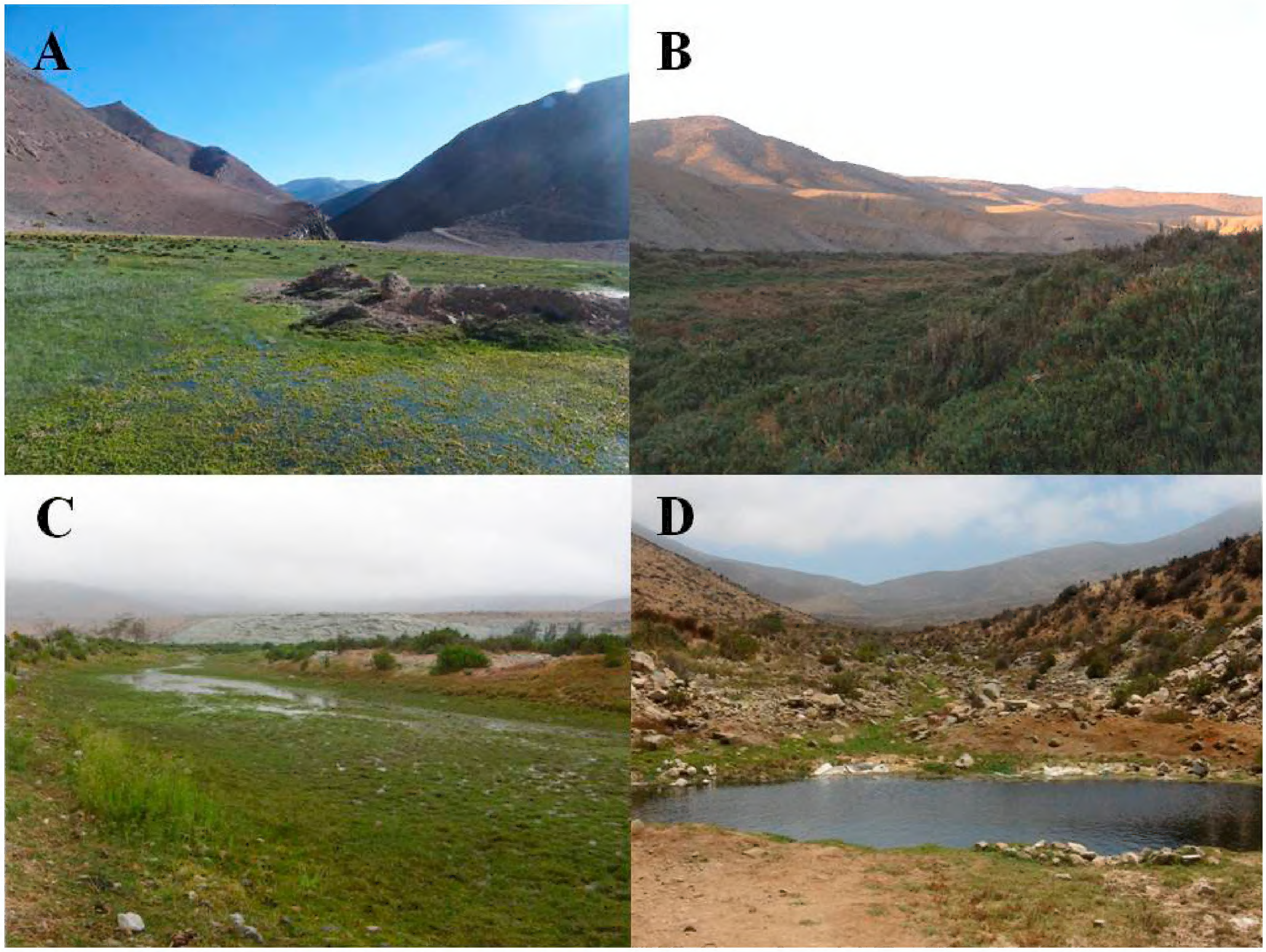

FIGURE 3. Panoramic view of some of the new localities described for *Pleurodema thaul*. **(A)** Río Figueroa; **(B)** Totoral; **(C)** El Trapiche; **(D)** Cruce a Chungungo.

integrity depends on scarce and irregular precipitation. The investigation of these aspects may be essential in order to implement conservation measures for these populations, which would also serve to protect other biotic components of these aquatic environments in Chile.

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